

FORM PTO-1390
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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

2821-205WOUS

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/831483INTERNATIONAL APPLICATION NO.
PCT/CH99/00518INTERNATIONAL FILING DATE
04 Nov. 1999PRIORITY DATE CLAIMED
18 Nov. 1998

TITLE OF INVENTION APPARATUS FOR HANDLING SHEETMETAL WORKPIECES TO BE WELDED

APPLICANT(S) FOR DO/EO/US

Daniel Wildmann, et al

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(3)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☒ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: Form PCT/IB/308-Notice informing the Applicant of the communication of the International Application to the Designated Offices.

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17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :**

Neither international preliminary examination fee (37 CFR 1.482)
nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO
and International Search Report not prepared by the EPO or JPO **\$1000.00**

International preliminary examination fee (37 CFR 1.482) not paid to
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International preliminary examination fee (37 CFR 1.482) not paid to USPTO but
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International preliminary examination fee paid to USPTO (37 CFR 1.482)
but all claims did not satisfy provisions of PCT Article 33(1)-(4) **\$690.00**

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months from the earliest claimed priority date (37 CFR 1.492(e)).

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CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims	22 - 20 =	2	X \$18.00
Independent claims	3 - 3 =	-0-	X \$80.00

\$ 36.00

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MULTIPLE DEPENDENT CLAIM(S) (if applicable)+ **\$270.00**

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☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above
are reduced by 1/2.

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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be
accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **\$40.00** per property

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a. ☒ A check in the amount of \$ 896.00 to cover the above fees is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

Richard D. Getz, Esq.
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Richard D. Getz

SIGNATURE.

Richard D. Getz, Esq. May 9, 2001

NAME

36,147

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(TYPED NAME OF PERSON MAILING PAPER OR FEE)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the Application of: : Docket No. 2821-205WOUS
Daniel Wildmann et al. : Date: 9 May, 2001
Serial No.: : G.A.U: Not Yet Known
: Examiner:

TITLE: APPARATUS FOR HANDLING SHEETMETAL WORKPIECES TO BE WELDED

Commissioner of Patents and Trademarks
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Applicants respectfully request preliminary amendments be made to the specification of the United States patent application identified above and provided herewith. The proposed amendments are made to the English translation of the specification of the PCT patent application Serial No. PCT/CH99/00518 from which the present application claims priority. The proposed changes are requested to put the specification in form acceptable to the United States Patent and Trademark Office, and to eliminate any indefiniteness that may exist in the translated version of the PCT specification. Applicants respectfully submit that the requested amendments do not add any new matter into the present application. Applicants include herewith a redline version of the English translation of the original PCT specification of the parent application showing the proposed amendments, and a copy of the same

specification with the proposed changes incorporated directly therein. In addition, a copy of FIGS. 3 and 4 of the original PCT drawings marked-up in redline with proposed changes, and a copy of the same with the proposed changes incorporated directly therein, are enclosed herewith.

A check in the amount of \$896.00 accompanies this amendment to cover the additional claims added. In the event a fee in excess of the amount provided for in the accompanying check is due, please charge our Deposit Order Account No. 13-0235.

Respectfully submitted,

MCCORMICK, PAULDING & HUBER

By Richard D. Getz

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K. A. Hansen
 (SIGNATURE OF PERSON MAILING PAPER OR FEE)

Method and apparatus for welding metal sheets with a laser
Apparatus for Handling Sheet Metal Workpieces to be Welded

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to methods and apparatus for welding
metal sheets in general, and to methods and apparatus for controlling the gap
between the metal sheets being welded in particular.

The present invention relates to a method according to the introductory part of
Claim 1, and an apparatus for carrying out the method.

2. Background Information.

Laser welding is now in widespread use as a process for joining metal sheets together. In this process the sheets are preferably butt jointed, with their edges positioned so that there is only a narrow gap between the sheets. To obtain a weld seam of high quality, the gap between the sheets to be joined should not be wider than 0.05 or 0.08 mm, and the deviations of each individual sheet should not exceed one half of these maximum permissible widths of gap. It is obvious that in order to observe such tolerances, correspondingly expensive tools, or complicated machining methods, are necessary.

It is known from European Patent Application No. EP 0565846 when welding straight seams to plastically deform at least one of the metal sheets with a squeeze roller before or in the welding zone so that the maximum permissible width of gap between the sheets to be joined is not exceeded. In connection

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with this known teaching, a series of embodiments are described which relate in particular to the varied configuration of the squeeze rollers.

The known teaching is only suitable for straight weld seams. In particular it is unsuitable if there is a requirement to guide the weld seams along a given line, as in such cases the squeeze rollers proposed in the known teaching generate lateral forces which can lead to undesired distortions of the metal sheets.

DISCLOSURE OF THE INVENTION

It is, therefore, an object of the present invention to provide a method and an apparatus for welding metal sheets that can weld a seam along any given line.

According to the present invention, an apparatus for handling a pair of sheet metal workpieces to be welded is provided that includes a first workpiece holder, a second workpiece holder, at least one backing element, and at least one squeeze roller. The first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpiece. The backing element is disposed on a first side of the sheet metal workpieces, and the squeeze roller is disposed on a second side of the sheetmetal workpieces opposite the first side. The squeeze roller is substantially aligned with the backing element. The squeeze roller is formed as a body symmetrical in rotation. Force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

Therefore the fundamental problem of the present invention is to specify a method with which the weld seams can follow any given line.

~~This problem is solved by the measures indicated in Claim 1. Advantageous configurations of the invention and an apparatus for carrying out the method are described in further claims.~~

The invention has the following advantages: Since a ~~squeezer~~ squeeze roller is used which obtains a plastic deformation that is independent of the ~~squeezer's~~ squeeze roller's direction of advance on the metal sheet concerned, the weld seam can be guided along any given line without risking insufficient deformation of the sheets to be welded. The method according to the invention and the apparatus for carrying out the method can therefore be used for welding sheets of any desired shape.

When, in a continuation of the invention, the ~~squeezer~~ squeeze roller consists of a ball, it moreover becomes possible to obtain an apparatus according to the invention that is extremely compact, as the radius of the ball is greatly reduced in comparison with the outer dimensions of the known squeeze rollers, which means that the force acting on the squeezer ball to yield a given effect can also be reduced.

Lastly, by forming the ~~squeezer~~ squeeze roller according to the invention as a ball, it is possible to set the mounting (or "support") of the ~~squeezer ball~~ squeeze roller at an oblique angle to the [plane formed] by the sheets to be welded. This leaves the joint line between the sheets freely accessible, so that in particular detection devices can be used to detect the actual width of gap between the sheets in the squeezing zone. The force acting on the squeezer ball can then be adjusted in response to the instantaneous value of the width of the gap.

These and other objects, features, and advantages of the present invention will become apparent in light of the Detailed Description of the Invention.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of the invention will now be given by way of example and with reference to drawings, in which

Fig. 1 shows a section through an arrangement according to the invention, made in the region of the welding zone, perpendicularly to two metal sheets of unequal thickness which are to be welded together,

Fig. 2 shows a section through a further embodiment of the invention, made perpendicularly to two metal sheets of equal thickness which are to be welded together,

Fig. 3 shows a similar section to Fig. 2 through a further embodiment of the invention, and

Fig. 4 shows a similar section to Fig. 2 through a further embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows a section through an apparatus according to the invention, made perpendicularly to two metal sheets 1 and 2 to be joined together, one of which is thicker than the other. The two sheets 1 and 2 lie with their edges adjacent and are butt welded together in this position. Welding is performed, in a manner known in itself, by a laser beam which in the welding zone has a focused cross-section with a diameter of e.g. 0.2 mm. In order for the weld to be of the necessary quality and to be free from defects, the gap between the adjoining sheets 1 and 2 in the welding zone should not exceed a maximum of 0.08 mm. If the gap is wider than this, sagging of the weld or burn-through by the beam will occur.

The sheet 2 is plastically deformed, before and/or in the welding zone and as shown in Fig. 1, by means of a squeezer squeeze roller 6 mounted on a support

~~7~~consisting of a mounting ~~7~~ and a ball ~~6~~ fitted therein, so that any gap present between the sheets 1 and 2 is reduced and/or so that the maximum permitted width of gap stated above is not exceeded. The ~~mounting support~~ 7 is pressed perpendicularly against the sheet 2, causing the deformed material to flow mainly in the direction of the arrow 8.

During the squeezing operation, the sheet 2 is supported by a backing element 9 located opposite the ~~squeezer ball~~ squeeze roller 6 acting on the sheet 2. Holding devices 3 and 4 (also referred to as "workpiece holders") are also provided which fix the two sheets 1 and 2 at least during the squeezing operation and/or during the ensuing welding operation. Actual clamps are used as holding devices 3 and 4.

The ~~mounting support~~ 7 in Fig. 1 is shown with an axis 10 which refers to the rotationally symmetrical configuration of the ~~mounting support~~ 7.

Fig. 2 shows a section through a further embodiment of the apparatus according to the invention. Here the metal sheets 1 and 2 for welding are of equal thickness. Instead of a single ~~squeezer ball~~ squeeze roller 6, two ~~squeezer balls~~ squeeze rollers 6 are used, each acting perpendicularly from above on one of the sheets 1 and 2. The special feature of this arrangement is that both sheets 1 and 2 are deformed, so that smaller deformations are necessary to achieve the same effect. In other words, this embodiment could be used to reduce relatively large gaps between welding sheets 1 and 2 to within the maximum permissible width.

A further embodiment which is shown in Fig. 3 differs from that of Fig. 2 in particular in that the axes 10 of the ~~mountings supports~~ 7 include an acute angle with the plane of the metal sheets 1 and 2. Sufficient room is thereby left at the joint 5 for the actual width of the gap to be detected for example by means of a detection device 14, so that the pressure force acting on the ~~mounting support~~ 7 can be adjusted accordingly by a control arrangement.

A further feature of the embodiment shown in Fig. 3 is that the backing element 9, which was in one piece in Fig. 2, is now shown divided in two. As a result, the underside of the joint 5 also becomes freely accessible, which again facilitates the determination of the width of the gap by means of the detection device 14.

Fig. 4 shows a preferred embodiment of the apparatus according to the invention, in which a mounting support 7 for a ~~squeezer ball~~ squeeze roller 6 is angled obliquely with respect to the plane formed by the metal sheet 1. The angled arrangement allows deformation of the sheet 1 to take place as close as possible to the joint 5. The sheet 2 is pressed against the backing element 9, and thus fixed in position, by a fixing unit 12 (also referred to as a "brake") which has at its lower end a fixing shoe 13 coming into contact with the sheet 2. This prevents the sheet 2 from being pushed back laterally should excessive deformation of the sheet 1 occur.

It can also be seen from Fig. 4 that the fixing unit 12 is in the form of a bar and is set at an oblique angle with respect to a plane formed by the sheet 2. Hence the joint 5 is again easily accessible for auxiliary devices 15.

The backing element 9 of the embodiment shown in Fig. 4 is formed as a roller with a rotational axis 11. The roller extends across the joint 5 and therefore supports both sheets 1 and 2. It would also be feasible to provide separate backing elements 9 for the sheets 1 and 2 in a similar fashion to those of Fig. 3 but forming each backing element 9 as a roller with a rotational axis 11.

Although this invention has been shown and described with respect to the detailed embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail thereof may be made without departing from the spirit and scope of the invention.

Claims:

1. ~~Method for welding metal sheets (1, 2) with a butt joint by means of a laser, in which at least one of the sheets (1, 2) is plastically deformed with a squeezer (6) before or in the welding zone to reduce the width of any gap present at the joint (5) between the sheets (1, 2), characterized in that the squeezer (6) is guided along a joint (5) of any desired curve form and in that the deformation produced is dependent on the force acting on the squeezer (6) but is independent of the line of the joint (5).~~
2. ~~Method according to Claim 1, characterized in that the deformation takes place in the region of the sheet(s) immediately adjacent to the edge of the sheet(s) (1, 2).~~
3. ~~Method according to Claim 1 or 2, characterized in that the laser beam is guided so as to track the position of the gap resulting from the deformation.~~
4. ~~Apparatus for carrying out the method according to any one of Claims 1 to 3, characterized in that the squeezer (6) is spherical and is preferably contained in a mounting (7).~~
5. ~~Apparatus according to Claim 4, characterized in that the squeezer (6) is formed as a squeezer ball (6), the squeezer ball (6) preferably being rotatably mounted in the mounting (7).~~
6. ~~Apparatus according to Claim 4 or 5, characterized in that the longitudinal axis (10) of at least one of the mountings (7) forms an acute angle with a plane formed by the sheets (1, 2).~~

7. Apparatus according to any one of Claims 4 to 6, characterized in that a fixing unit (12) whose longitudinal axis preferably includes an acute angle with the plane formed by the sheets (1, 2) acts on one of the sheets (1, 2) in the region of the joint (5).

8. Apparatus according to any one of Claims 4 to 7, characterized in that holding devices (3, 4) are provided which [fix] the sheets (1, 2) with their edges adjacent to each other.

9. Apparatus according to any one of Claims 4 to 8, characterized in that a detection device for detecting the width of the gap before the deformation zone, and a control arrangement which controls the mounting (7) as a function of the detected gap width, are provided.

10. Apparatus according to any one of Claims 4 to 9, characterized in that an optical recognition device or mechanical sensing device for identifying the line of the gap after deformation, and a tracking arrangement, responding to the recognition or sensing device, for guiding the laser beam along the line of the gap, are provided.

11. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces;

a backing element disposed on a first side of the sheet metal workpieces; and

a squeeze roller, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing element, wherein the squeeze roller is formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

12. The apparatus of claim 11, wherein the squeeze roller is spherically shaped.

13. The apparatus of claim 12, wherein the squeeze roller is mounted on a support to permit rotation in any direction.

14. The apparatus of claim 13, wherein the support forms an acute angle with a plane formed by the sheetmetal workpieces.

15. The apparatus of claim 14, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

16. The apparatus of claim 15, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

17. The apparatus of claim 16, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

18. The apparatus of claim 17, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

19. The apparatus of claim 13, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

20. The apparatus of claim 19, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

21. The apparatus of claim 13, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

22. The apparatus of claim 13, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

23. The apparatus of claim 11, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

24. The apparatus of claim 23, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

25. The apparatus of claim 11, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

26. The apparatus of claim 11, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

27. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces; and

means for plastically deforming one of the sheet metal workpieces, wherein said means for plastically deforming one of the sheetmetal workpieces can be selectively applied to cause that sheet metal workpiece to extend into the gap.

28. The apparatus of claim 27, wherein the means for plastically deforming one of the sheet metal workpieces comprises:

a backing element disposed on a first side of the sheet metal workpieces; and

a squeeze roller, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing element, wherein the squeeze roller is formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

29. The apparatus of claim 28, wherein the squeeze roller is spherically shaped and is mounted on a support to permit rotation in any direction.

30. The apparatus of claim 28, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

31. The apparatus of claim 28, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

32. The apparatus of claim 28, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

33. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces;

a pair of backing elements disposed on a first side of the sheet metal workpieces; and

a pair of squeeze rollers, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing elements, wherein the squeeze rollers are formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze rollers will cause plastic deformation in the pair of sheet metal workpieces and thereby cause the sheet metal workpieces to extend into the gap.

34. The apparatus of claim 33, wherein the squeeze rollers are spherically shaped.

35. The apparatus of claim 34, wherein each of the squeeze rollers is mounted on a support to permit rotation in any direction.

ABSTRACT OF THE DISCLOSURE

An apparatus for handling a pair of sheet metal workpieces to be welded is provided that includes a first workpiece holder, a second workpiece holder, at least one backing element, and at least one squeeze roller. The first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpiece. The backing element is disposed on a first side of the sheet metal workpieces, and the squeeze roller is disposed on a second side of the sheetmetal workpieces opposite the first side. The squeeze roller is substantially aligned with the backing element. The squeeze roller is formed as a body symmetrical in rotation. Force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

Fig. 3

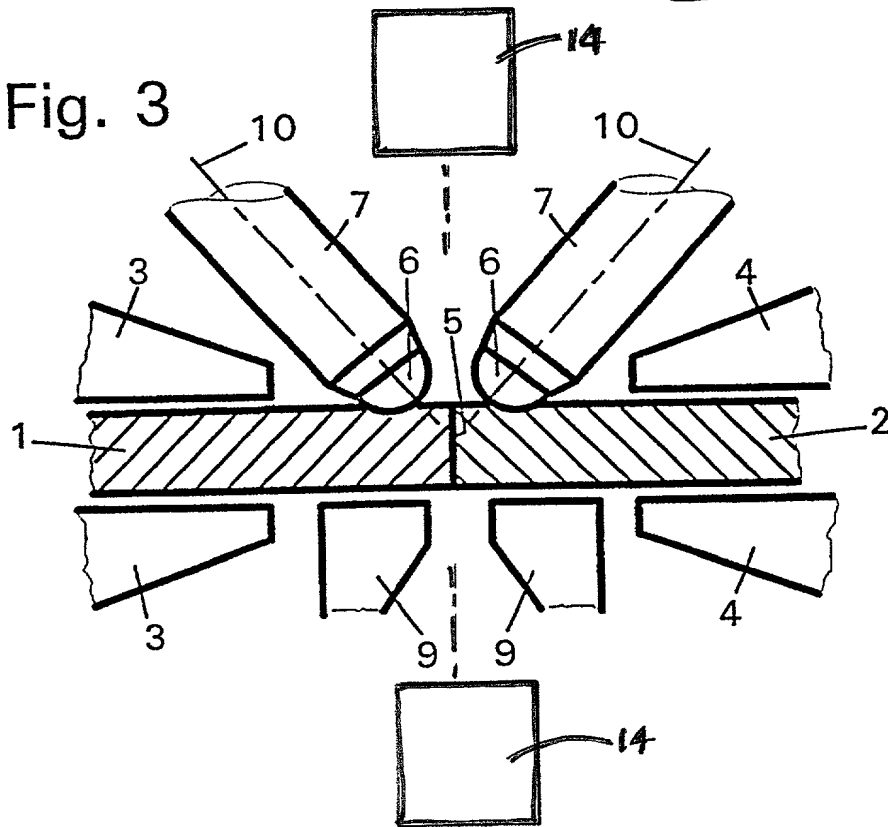
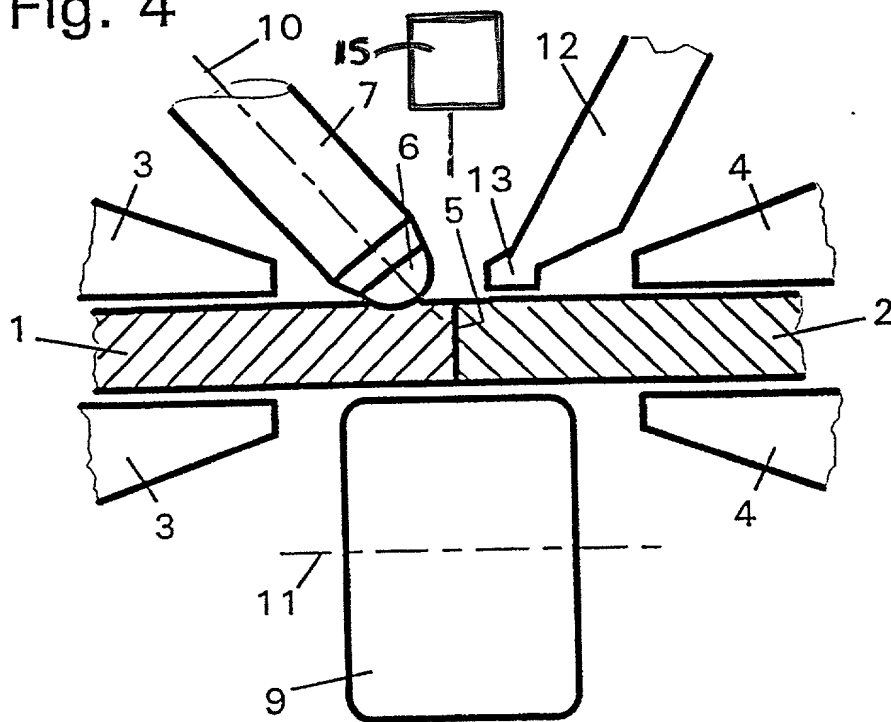


Fig. 4



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K.A. HANSEN

(TYPED NAME OF PERSON MAILING PAPER OR FEE)

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Apparatus for Handling Sheet Metal Workpieces to be Welded

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] The present invention relates to methods and apparatus for welding metal sheets in general, and to methods and apparatus for controlling the gap between the metal sheets being welded in particular.

2. Background Information.

[0002] Laser welding is now in widespread use as a process for joining metal sheets together. In this process the sheets are preferably butt jointed, with their edges positioned so that there is only a narrow gap between the sheets. To obtain a weld seam of high quality, the gap between the sheets to be joined should not be wider than 0.05 or 0.08 mm, and the deviations of each individual sheet should not exceed one half of these maximum permissible widths of gap. It is obvious that in order to observe such tolerances, correspondingly expensive tools, or complicated machining methods, are necessary.

[0003] It is known from European Patent Application No. EP 0565846 when welding straight seams to plastically deform at least one of the metal sheets with a squeeze roller before or in the welding zone so that the maximum permissible width of gap between the sheets to be joined is not exceeded. In connection with this known teaching, a series of embodiments

are described which relate in particular to the varied configuration of the squeeze rollers.

[0004] The known teaching is only suitable for straight weld seams. In particular it is unsuitable if there is a requirement to guide the weld seams along a given line, as in such cases the squeeze rollers proposed in the known teaching generate lateral forces which can lead to undesired distortions of the metal sheets.

DISCLOSURE OF THE INVENTION

[0005] It is, therefore, an object of the present invention to provide a method and an apparatus for welding metal sheets that can weld a seam along any given line.

[0006] According to the present invention, an apparatus for handling a pair of sheet metal workpieces to be welded is provided that includes a first workpiece holder, a second workpiece holder, at least one backing element, and at least one squeeze roller. The first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpiece. The backing element is disposed on a first side of the sheet metal workpieces, and the squeeze roller is disposed on a second side of the sheetmetal workpieces opposite the first side. The squeeze roller is substantially aligned with the backing element. The squeeze roller is formed as a body symmetrical in rotation. Force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

[0007] The invention has the following advantages: Since a squeeze roller is used which obtains a plastic deformation that is independent of the squeeze roller's direction of advance on the metal sheet concerned, the weld

seam can be guided along any given line without risking insufficient deformation of the sheets to be welded. The method according to the invention and the apparatus for carrying out the method can therefore be used for welding sheets of any desired shape.

[0008] When, in a continuation of the invention, the squeeze roller consists of a ball, it moreover becomes possible to obtain an apparatus according to the invention that is extremely compact, as the radius of the ball is greatly reduced in comparison with the outer dimensions of the known squeeze rollers, which means that the force acting on the squeezer ball to yield a given effect can also be reduced.

[0009] Lastly, by forming the squeeze roller according to the invention as a ball, it is possible to set the mounting (or "support") of the squeeze roller at an oblique angle to the plane formed by the sheets to be welded. This leaves the joint line between the sheets freely accessible, so that detection devices can be used to detect the actual width of gap between the sheets in the squeezing zone. The force acting on the squeezer ball can then be adjusted in response to the instantaneous value of the width of the gap.

[0010] These and other objects, features, and advantages of the present invention will become apparent in light of the Detailed Description of the Invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] A detailed description of the invention will now be given by way of example and with reference to drawings, in which

[0012] Fig. 1 shows a section through an arrangement according to the invention, made in the region of the welding zone, perpendicularly to two metal sheets of unequal thickness which are to be welded together;

[0013] Fig. 2 shows a section through a further embodiment of the invention, made perpendicularly to two metal sheets of equal thickness which are to be welded together;

[0014] Fig. 3 shows a similar section to Fig. 2 through a further embodiment of the invention; and

[0015] Fig. 4 shows a similar section to Fig. 2 through a further embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Fig. 1 shows a section through an apparatus according to the invention, made perpendicularly to two metal sheets 1 and 2 to be joined together, one of which is thicker than the other. The two sheets 1 and 2 lie with their edges adjacent and are butt welded together in this position. Welding is performed, in a manner known in itself, by a laser beam which in the welding zone has a focused cross-section with a diameter of e.g. 0.2 mm. In order for the weld to be of the necessary quality and to be free from defects, the gap between the adjoining sheets 1 and 2 in the welding zone should not exceed a maximum of 0.08 mm. If the gap is wider than this, sagging of the weld or burn-through by the beam will occur.

[0017] The sheet 2 is plastically deformed, before and/or in the welding zone and as shown in Fig. 1, by means of a squeeze roller 6 mounted on a support 7, so that any gap present between the sheets 1 and 2 is reduced and/or so that the maximum permitted width of gap stated above is not exceeded. The support 7 is pressed perpendicularly against the sheet 2, causing the deformed material to flow mainly in the direction of the arrow 8.

[0018] During the squeezing operation, the sheet 2 is supported by a backing element 9 located opposite the squeeze roller 6 acting on the sheet 2. Holding devices 3 and 4 (also referred to as "workpiece holders") are also provided which fix the two sheets 1 and 2 at least during the squeezing operation and/or during the ensuing welding operation. Actual clamps are used as holding devices 3 and 4. The support 7 in Fig. 1 is shown with an axis 10 which refers to the rotationally symmetrical configuration of the support 7.

[0019] Fig. 2 shows a section through a further embodiment of the apparatus according to the invention. Here the metal sheets 1 and 2 for welding are of equal thickness. Instead of a single squeeze roller 6, two squeeze rollers 6 are used, each acting perpendicularly from above on one of

the sheets 1 and 2. The special feature of this arrangement is that both sheets 1 and 2 are deformed, so that smaller deformations are necessary to achieve the same effect. In other words, this embodiment could be used to reduce relatively large gaps between welding sheets 1 and 2 to within the maximum permissible width.

[0020] A further embodiment which is shown in Fig. 3 differs from that of Fig. 2 in particular in that the axes 10 of the supports 7 include an acute angle with the plane of the metal sheets 1 and 2. Sufficient room is thereby left at the joint 5 for the actual width of the gap to be detected for example by means of a detection device 14, so that the pressure force acting on the support 7 can be adjusted accordingly by a control arrangement.

[0021] A further feature of the embodiment shown in Fig. 3 is that the backing element 9, which was in one piece in Fig. 2, is now shown divided in two. As a result, the underside of the joint 5 also becomes freely accessible, which again facilitates the determination of the width of the gap by means of the detection device 14.

[0022] Fig. 4 shows a preferred embodiment of the apparatus according to the invention, in which a support 7 for a squeeze roller 6 is angled obliquely with respect to the plane formed by the metal sheet 1. The angled arrangement allows deformation of the sheet 1 to take place as close as possible to the joint 5. The sheet 2 is pressed against the backing element 9, and thus fixed in position, by a fixing unit 12 (also referred to as a "brake") which has at its lower end a fixing shoe 13 coming into contact with the sheet 2. This prevents the sheet 2 from being pushed back laterally should excessive deformation of the sheet 1 occur.

[0023] It can also be seen from Fig. 4 that the fixing unit 12 is in the form of a bar and is set at an oblique angle with respect to a plane formed by the sheet 2. Hence the joint 5 is again easily accessible for auxiliary devices 15.

[0024] The backing element 9 of the embodiment shown in Fig. 4 is formed as a roller with a rotational axis 11. The roller extends across the joint 5 and therefore supports both sheets 1 and 2. It would also be feasible to

provide separate backing elements 9 for the sheets 1 and 2 in a similar fashion to those of Fig. 3 but forming each backing element 9 as a roller with a rotational axis 11.

[0025] Although this invention has been shown and described with respect to the detailed embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail thereof may be made without departing from the spirit and scope of the invention.

What is claimed is:

11. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces;

a backing element disposed on a first side of the sheet metal workpieces; and

a squeeze roller, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing element, wherein the squeeze roller is formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

12. The apparatus of claim 11, wherein the squeeze roller is spherically shaped.

13. The apparatus of claim 12, wherein the squeeze roller is mounted on a support to permit rotation in any direction.

14. The apparatus of claim 13, wherein the support forms an acute angle with a plane formed by the sheetmetal workpieces .

15. The apparatus of claim 14, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

16. The apparatus of claim 15, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

17. The apparatus of claim 16, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

18. The apparatus of claim 17, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

19. The apparatus of claim 13, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

20. The apparatus of claim 19, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

21. The apparatus of claim 13, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

22. The apparatus of claim 13, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

23. The apparatus of claim 11, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

24. The apparatus of claim 23, wherein the workpiece brake is disposed at an acute angle relative to the contacted sheet metal workpiece.

25. The apparatus of claim 11, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

26. The apparatus of claim 11, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

27. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces; and

means for plastically deforming one of the sheet metal workpieces, wherein said means for plastically deforming one of the sheetmetal workpieces can be selectively applied to cause that sheet metal workpiece to extend into the gap.

28. The apparatus of claim 27, wherein the means for plastically deforming one of the sheet metal workpieces comprises:

a backing element disposed on a first side of the sheet metal workpieces; and

a squeeze roller, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing element, wherein the squeeze roller is formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

29. The apparatus of claim 28, wherein the squeeze roller is spherically shaped and is mounted on a support to permit rotation in any direction.

30. The apparatus of claim 28, further comprising a workpiece brake that can be selectively actuated into contact with one of the sheetmetal workpieces and thereby cause the contacted sheetmetal workpiece to be clamped between the backing element and the workpiece brake.

31. The apparatus of claim 28, further comprising:

a gap sensing device for sensing the width of the gap adjacent the squeeze roller;

a controller for controlling the amount of force applied to the squeeze roller as a function of the gap adjacent the squeeze roller, thereby controlling the gap between the sheetmetal workpieces.

32. The apparatus of claim 28, further comprising a gap position sensor for determining the position of the gap after deformation, and a welding machine guide operably connected to the gap position sensor, wherein the welding machine guide guides the welding machine relative to the gap using input from the gap position sensor.

33. An apparatus for handling a pair of sheet metal workpieces to be welded, comprising:

a first workpiece holder;

a second workpiece holder;

wherein the first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpieces;

a pair of backing elements disposed on a first side of the sheet metal workpieces; and

a pair of squeeze rollers, disposed on a second side of the sheetmetal workpieces opposite the first side and substantially aligned with the backing elements, wherein the squeeze rollers are formed as a body symmetrical in rotation, and wherein force selectively applied to the squeeze rollers will cause plastic deformation in the pair of sheet metal workpieces and thereby cause the sheet metal workpieces to extend into the gap.

34. The apparatus of claim 33, wherein the squeeze rollers are spherically shaped.

35. The apparatus of claim 34, wherein each of the squeeze rollers is mounted on a support to permit rotation in any direction.

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Method and apparatus for welding metal sheets with a laser

The present invention relates to a method according to the introductory part of Claim 1, and an apparatus for carrying out the method.

Laser welding is now in widespread use as a process for joining metal sheets together. In this process the sheets are preferably butt jointed, with their edges positioned so that there is only a narrow gap between the sheets. To obtain a weld seam of high quality, the gap between the sheets to be joined should not be wider than 0.05 or 0.08 mm, and the deviations of each individual sheet should not exceed one half of these maximum permissible widths of gap. It is obvious that in order to observe such tolerances, correspondingly expensive tools, or complicated machining methods, are necessary.

It is known from European patent application EP 0565846 when welding straight seams to plastically deform at least one of the metal sheets with a squeeze roller before or in the welding zone so that the maximum permissible width of gap between the sheets to be joined is not exceeded. In connection with this known teaching, a series of embodiments are described which relate in particular to the varied configuration of the squeeze rollers.

The known teaching is only suitable for straight weld seams. In particular it is unsuitable if there is a requirement to guide the weld seams along a given line, as in such cases the squeeze rollers proposed in the known teaching generate lateral forces which can lead to undesired distortions of the metal sheets.

Therefore the fundamental problem of the present invention is to specify a method with which the weld seams can follow any given line.

This problem is solved by the measures indicated in Claim 1. Advantageous configurations of the invention and an apparatus for carrying out the method are described in further claims.

The invention has the following advantages: Since a squeezer is used which obtains a plastic deformation that is independent of the squeezer's direction of advance on the metal sheet concerned, the weld seam can be guided along any given line without risking insufficient deformation of the sheets to be welded. The method according to the invention and the apparatus for carrying out the method can therefore be used for welding sheets of any desired shape.

When, in a continuation of the invention, the squeezer consists of a ball, it moreover becomes possible to obtain an apparatus according to the invention that is extremely compact, as the radius of the ball is greatly reduced in comparison with the outer dimensions of the known squeeze rollers, which means that the force acting on the squeezer ball to yield a given effect can also be reduced.

Lastly, by forming the squeezer according to the invention as a ball, it is possible to set the mounting of the squeezer ball at an oblique angle to the [plane formed] by the sheets to be welded. This leaves the joint line between the sheets freely accessible, so that in particular detection devices can be used to detect the actual width of gap between the sheets in the squeezing zone. The force acting on the squeezer ball can then be adjusted in response to the instantaneous value of the width of the gap.

A detailed description of the invention will now be given by way of example and with reference to drawings, in which

Fig. 1 shows a section through an arrangement according to the invention, made in the region of the welding zone, perpendicularly to two metal sheets of unequal thickness which are to be welded together,

Fig. 2 shows a section through a further embodiment of the invention, made perpendicularly to two metal sheets of equal thickness which are to be welded together,

Fig. 3 shows a similar section to Fig. 2 through a further embodiment of the invention, and

Fig. 4 shows a similar section to Fig. 2 through a further embodiment of the invention.

Fig. 1 shows a section through an apparatus according to the invention, made perpendicularly to two metal sheets 1 and 2 to be joined together, one of which is thicker than the other. The two sheets 1 and 2 lie with their edges adjacent and are butt welded together in this position. Welding is performed, in a manner known in itself, by a laser beam which in the welding zone has a focused cross-section with a diameter of e.g. 0.2 mm. In order for the weld to be of the necessary quality and to be free from defects, the gap between the adjoining sheets 1 and 2 in the welding zone should not exceed a maximum of 0.08 mm. If the gap is wider than this, sagging of the weld or burn-through by the beam will occur.

The sheet 2 is plastically deformed, before and/or in the welding zone and as shown in Fig. 1, by means of a squeezer consisting of a mounting 7 and a ball 6 fitted therein, so that any gap present between the sheets 1 and 2 is reduced and/or so that the maximum permitted width of gap stated above is not exceeded. The mounting 7 is pressed perpendicularly against the sheet 2, causing the deformed material to flow mainly in the direction of the arrow 8.

During the squeezing operation, the sheet 2 is supported by a backing element 9 located opposite the squeezer ball 6 acting on the sheet 2. Holding devices 3 and 4 are also provided which fix the two sheets 1 and 2 at least during the squeezing operation and/or during the ensuing welding operation. Actual clamps are used as holding devices 3 and 4.

The mounting 7 in Fig. 1 is shown with an axis 10 which refers to the rotationally symmetrical configuration of the mounting 7.

Fig. 2 shows a section through a further embodiment of the apparatus according to the invention. Here the metal sheets 1 and 2 for welding are of equal thickness. Instead of a single squeezer ball 7, two squeezer balls 7 are used, each acting perpendicularly from above on one of the sheets 1 and 2. The special feature of this arrangement is that both sheets 1 and 2 are deformed, so that smaller deformations are necessary to achieve the same effect. In other words, this embodiment could be used to reduce relatively large gaps between welding sheets 1 and 2 to within the maximum permissible width.

A further embodiment which is shown in Fig. 3 differs from that of Fig. 2 in particular in that the axes 10 of the mountings 7 include an acute angle with the plane of the metal sheets 1 and 2. Sufficient room is thereby left at the joint 5 for the actual width of gap to be detected for example by means of a detection device, so that the pressure force acting on the mounting 7 can be adjusted accordingly by a control arrangement.

A further feature of the embodiment shown in Fig. 3 is that the backing element 9, which was in one piece in Fig. 2, is now shown divided in two. As a result, the underside of the joint 5 also becomes freely accessible, which again facilitates the determination of the width of the gap by means of the detection device.

Fig. 4 shows a preferred embodiment of the apparatus according to the invention, in which a mounting 7 for a squeezer ball 6 is angled obliquely with respect to the plane

formed by the metal sheet 1. The angled arrangement allows deformation of the sheet 1 to take place as close as possible to the joint 5. The sheet 2 is pressed against the backing element 9, and thus fixed in position, by a fixing unit 12 which has at its lower end a fixing shoe 13 coming into contact with the sheet 2. This prevents the sheet 2 from being pushed back laterally should excessive deformation of the sheet 1 occur.

It can also be seen from Fig. 4 that the fixing unit 12 is in the form of a bar and is set at an oblique angle with respect to a plane formed by the sheet 2. Hence the joint 5 is again easily accessible for auxiliary devices.

The backing element 9 of the embodiment shown in Fig. 4 is formed as a roller with a rotational axis 11. The roller extends across the joint 5 and therefore supports both sheets 1 and 2. It would also be feasible to provide separate backing elements 9 for the sheets 1 and 2 in a similar fashion to those of Fig. 3 but forming each backing element 9 as a roller with a rotational axis 11.

Claims:

1. Method for welding metal sheets (1, 2) with a butt joint by means of a laser, in which at least one of the sheets (1, 2) is plastically deformed with a squeezer (6) before or in the welding zone to reduce the width of any gap present at the joint (5) between the sheets (1, 2), characterized in that the squeezer (6) is guided along a joint (5) of any desired curve form and in that the deformation produced is dependent on the force acting on the squeezer (6) but is independent of the line of the joint (5).
2. Method according to Claim 1, characterized in that the deformation takes place in the region of the sheet(s) immediately adjacent to the edge of the sheet(s) (1, 2).
3. Method according to Claim 1 or 2, characterized in that the laser beam is guided so as to track the position of the gap resulting from the deformation.
4. Apparatus for carrying out the method according to any one of Claims 1 to 3, characterized in that the squeezer (6) is spherical and is preferably contained in a mounting (7).
5. Apparatus according to Claim 4, characterized in that the squeezer (6) is formed as a squeezer ball (6), the squeezer ball (6) preferably being rotatably mounted in the mounting (7).
6. Apparatus according to Claim 4 or 5, characterized in that the longitudinal axis (10) of at least one of the mountings (7) forms an acute angle with a plane formed by the sheets (1, 2).
7. Apparatus according to any one of Claims 4 to 6, characterized in that a fixing unit (12) whose longitudinal axis preferably includes an acute angle with the plane formed by the sheets (1, 2) acts on one of the sheets (1, 2) in the region of the joint (5).
8. Apparatus according to any one of Claims 4 to 7, characterized in that holding devices (3, 4) are provided which [fix] the sheets (1, 2) with their edges adjacent to each other.
9. Apparatus according to any one of Claims 4 to 8, characterized in that a detection device for detecting the width of the gap before the deformation zone, and a control

arrangement which controls the mounting (7) as a function of the detected gap width, are provided.

10. Apparatus according to any one of Claims 4 to 9, characterized in that an optical recognition device or mechanical sensing device for identifying the line of the gap after deformation, and a tracking arrangement, responding to the recognition or sensing device, for guiding the laser beam along the line of the gap, are provided.

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Fig. 3

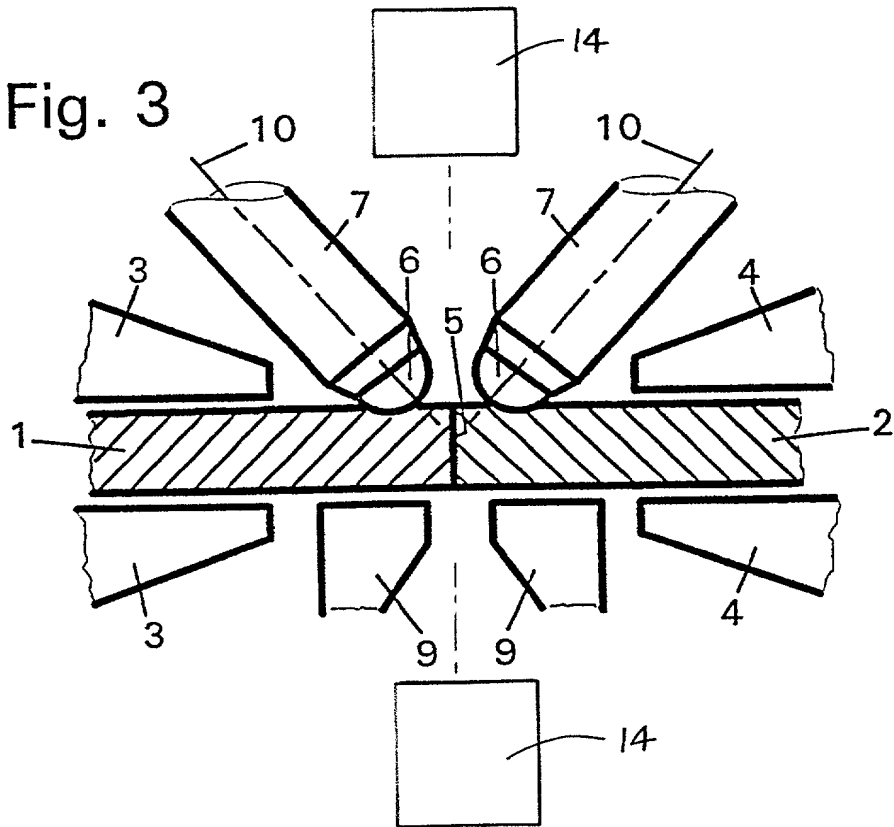
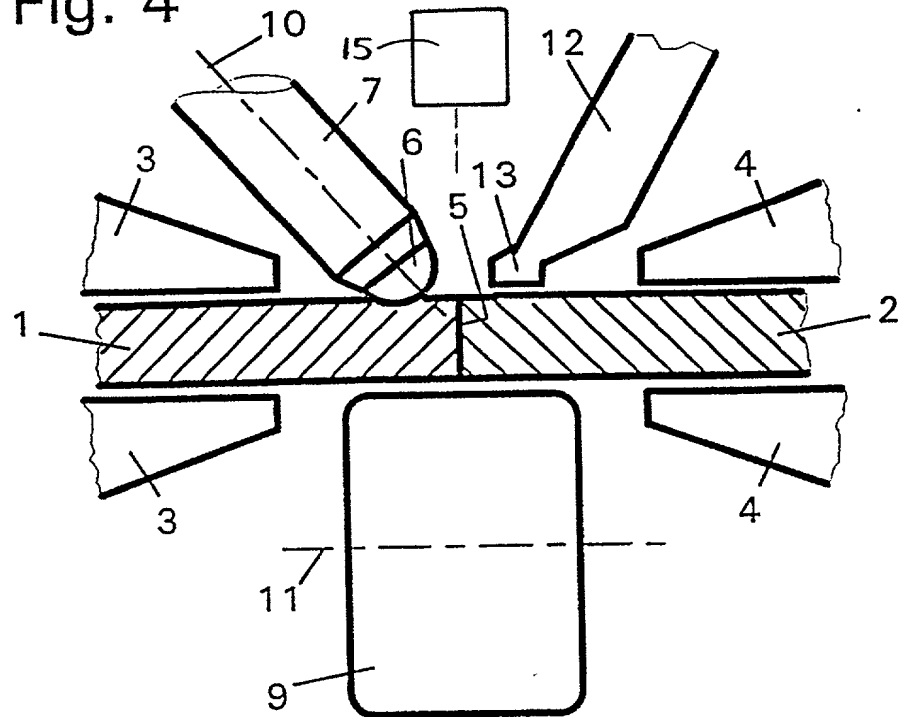


Fig. 4



ABSTRACT OF THE DISCLOSURE

An apparatus for handling a pair of sheet metal workpieces to be welded is provided that includes a first workpiece holder, a second workpiece holder, at least one backing element, and at least one squeeze roller. The first and second workpiece holders are positioned so that an edge of one of the pair of sheet metal workpieces is in contact with, or separated a gap from, an edge of the other sheetmetal workpiece. The backing element is disposed on a first side of the sheet metal workpieces, and the squeeze roller is disposed on a second side of the sheetmetal workpieces opposite the first side. The squeeze roller is substantially aligned with the backing element. The squeeze roller is formed as a body symmetrical in rotation. Force selectively applied to the squeeze roller will cause plastic deformation of one of the pair of sheet metal workpieces and thereby cause the deformed sheet metal workpiece to extend into the gap.

**DECLARATION, POWER OF ATTORNEY AND
APPOINTMENT OF DOMESTIC REPRESENTATIVE**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD AND DEVICE FOR LASER WELDING METAL SHEETS

the specification of which

(Check ☐ is attached hereto.

one) ☒ was filed on _____ as

Application Serial No

and was amended on _____.

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose the U.S. Patent and Trademark Office all information known to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulation, §§1.56 and 1.63(d).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Applications

Priority
Claimed

2308/98
(Number)

Switzerland
(Country)

November 18, 1998
(Month/Day/Year Filed)

XX
Yes No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §§1.56 and 1.63(d) which occurred between the filing date of the prior application and the national or PCT international filing date of this application(s):

(Application Serial No.)

(Filing date)

(Status) (Patented,
pending, abandoned)

Power of Attorney

I hereby appoint THEODORE R. PAULDING, Registration No. 19,294; DONALD K. HUBER, Registration No. 18,686; JOHN C. HILTON, Registration No. 22,965; FREDERICK J. HAESCHE, Registration No. 24,529; JOHN C. LINDERMAN, Registration No. 24,420; J. KEVIN GROGAN, Registration No. 31,961; JOSEPH S. KENTOFFIO, Registration No. 33,189; MARK D. GIARRATANA, Registration No. 32,615; F. TYLER MORRISON III, Registration No. 36,220 and ROBERT CRAWFORD, Registration No. 38,119; all of the firm of McCORMICK, PAULDING & HUBER, CityPlace II, 185 Asylum Street, Hartford, Connecticut 06103-4102, Telephone No. (860) 549-5290, as my attorneys to prosecute this application, to make alterations and amendments therein, to receive the patent and all correspondence relating to this application, and to transact all business in the U.S. Patent and Trademark Office connected therewith, and the said attorneys are hereby given full power of substitution and revocation.

APPOINTMENT OF DOMESTIC REPRESENTATIVE

The above-identified attorneys, also known as McCORMICK, PAULDING & HUBER, whose postal address is CityPlace II, 185 Asylum Street, Hartford, Connecticut 06103-4102, United States of America, are hereby designated applicant's representative upon whom notices or process in proceedings affecting the patent may be served. Said firm shall take instructions from my foreign patent agents in all matters affecting this application and the patent.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by

fine or imprisonment, or both, under Section 1001 Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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In the Application of: : Docket No. 2821-205WOUS
Daniel Wildmann, et al : Date: 9 May 2001
Serial No: : G.A.U.: Not Yet Known
: Examiner:

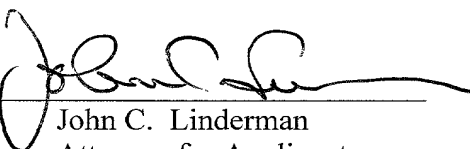
TITLE: APPARATUS FOR HANDLING SHEETMETAL WORKPIECES TO BE WELDED
Commissioner of Patents and Trademarks
Washington, D.C. 20231

APPOINTMENT OF ASSOCIATE ATTORNEY

SIR:

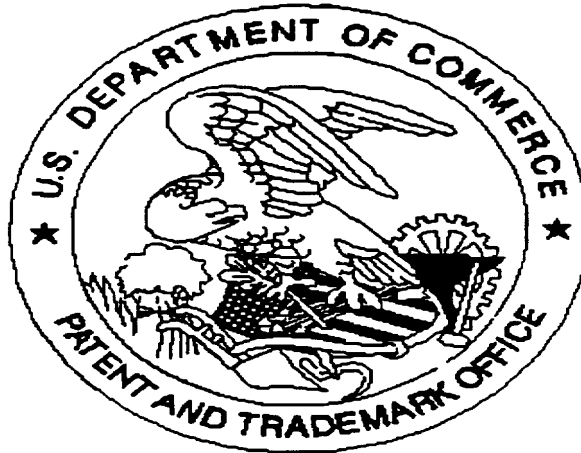
I, John C. Linderman, Registration No. 24,420, am principal attorney of record in the
above-identified application, and hereby appoint Richard D. Getz, as an associate attorney of
record in the above-identified patent application.

Respectfully submitted,

By 
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